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**Rachkov**

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(54) **ADJUSTABLE MICRO DEVICE FEEDER**

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 840 days.

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See application file for complete search history.

(57) **ABSTRACT**

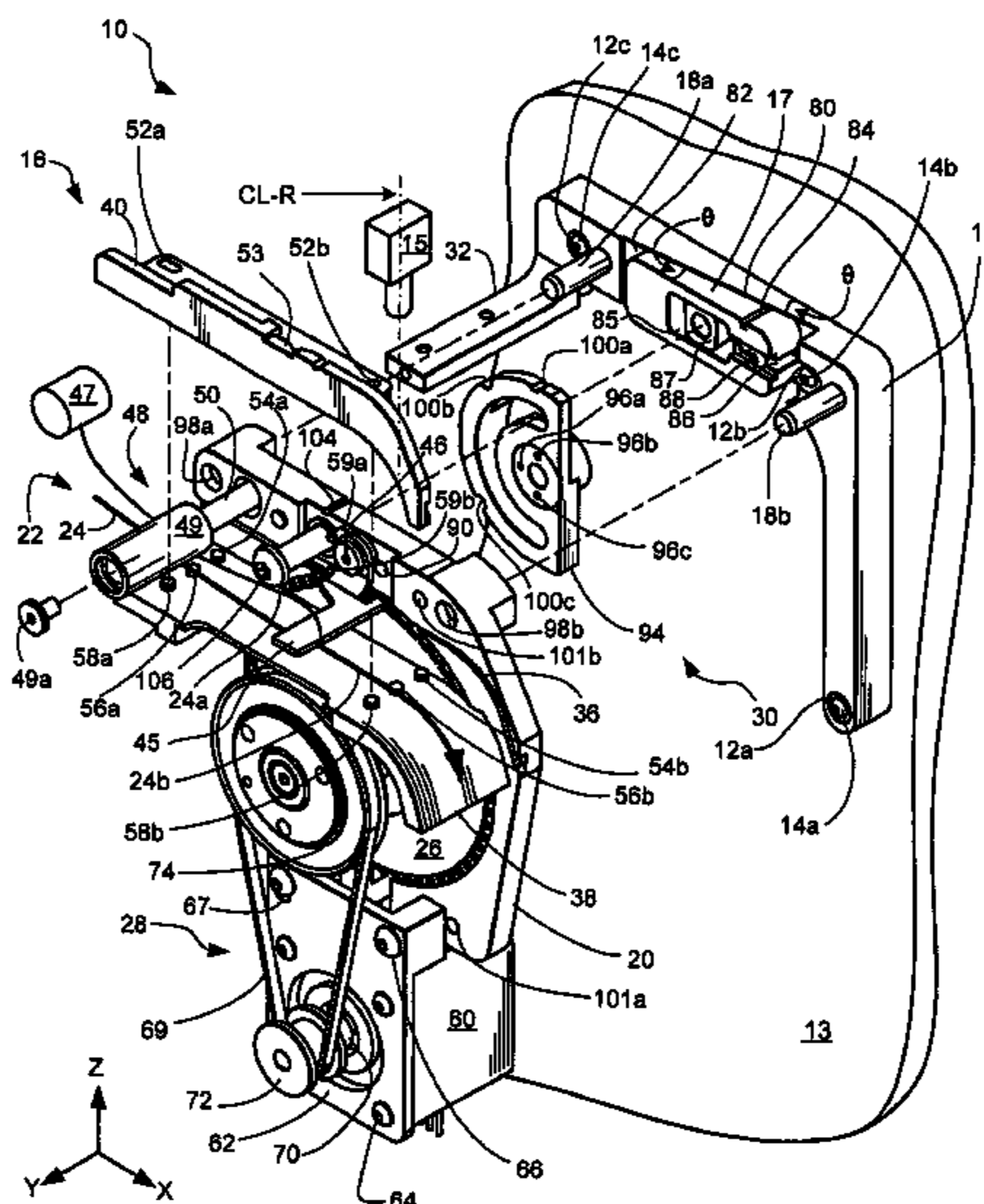
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A micro device feeder is provided which is adjustable to accommodate micro devices supplied on tapes with different widths. A mounting plate has a movable drive plate slidably mounted thereto. An input mechanism on the movable drive plate receives micro devices contained in a tape and advances the tape under motor drive. A feeder width adjustment mechanism is interposed between the mounting plate and the movable drive plate for positioning of the movable drive plate relative to the mounting plate for accommodating tapes with different widths.

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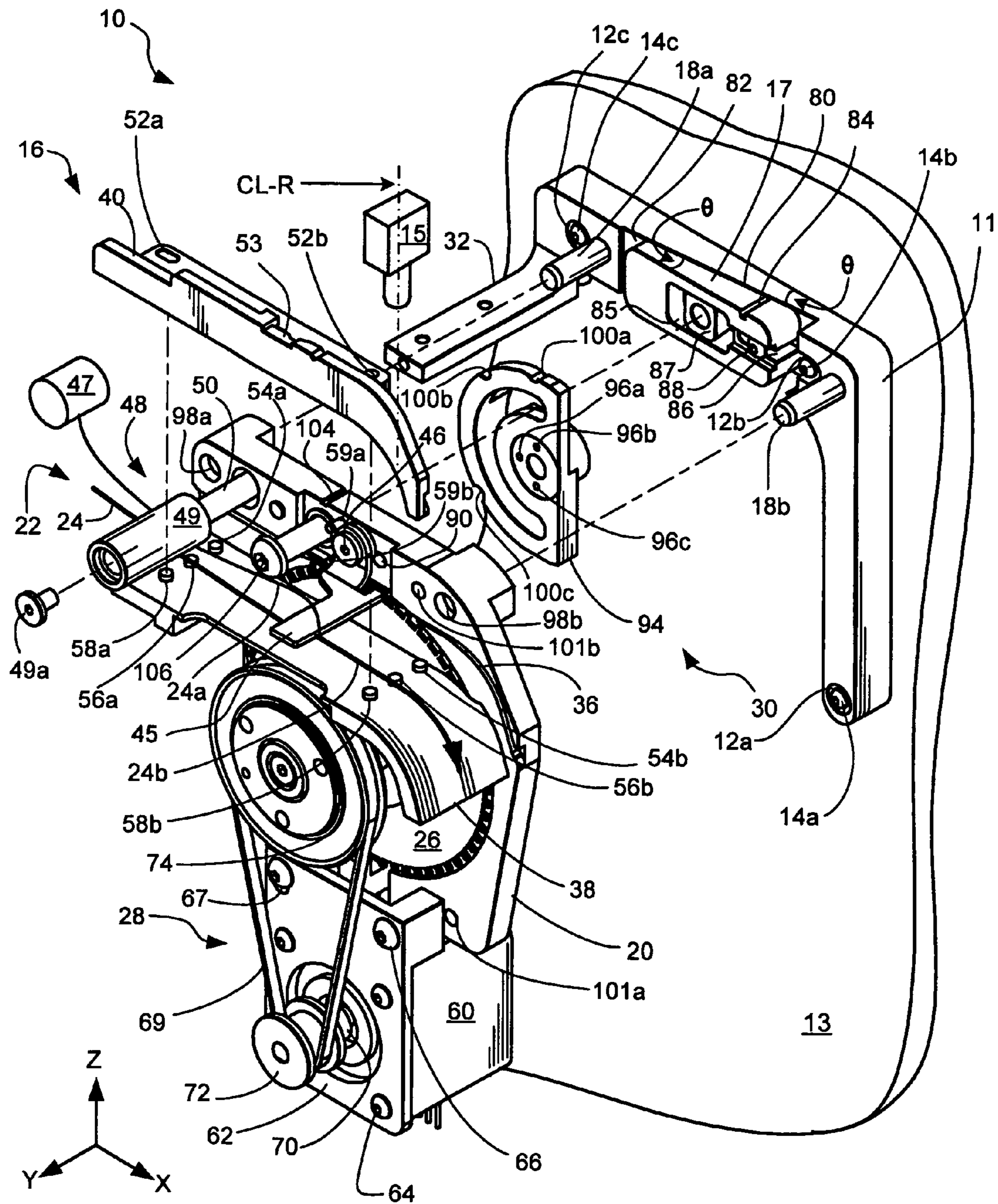


FIG. 1

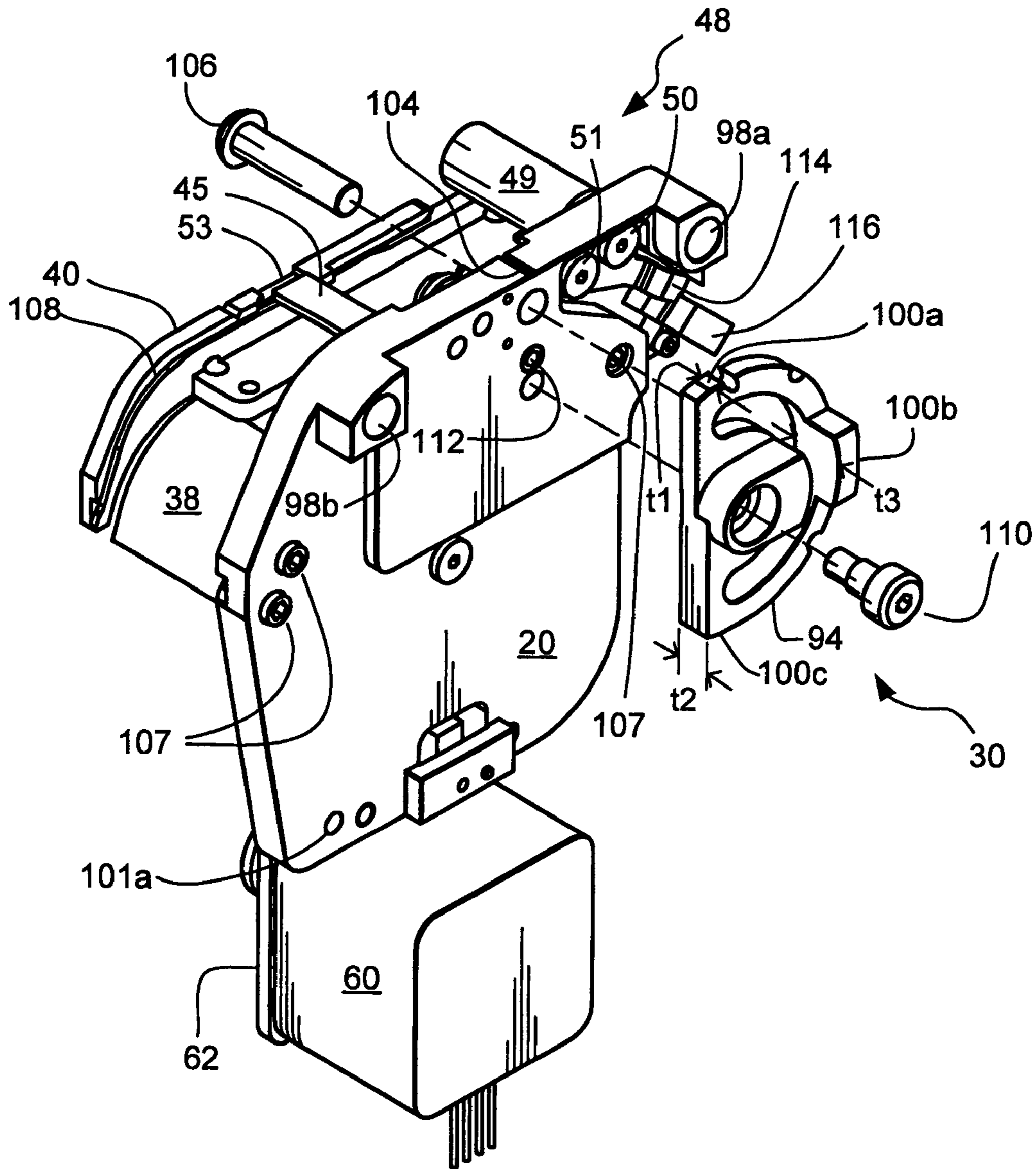


FIG. 2

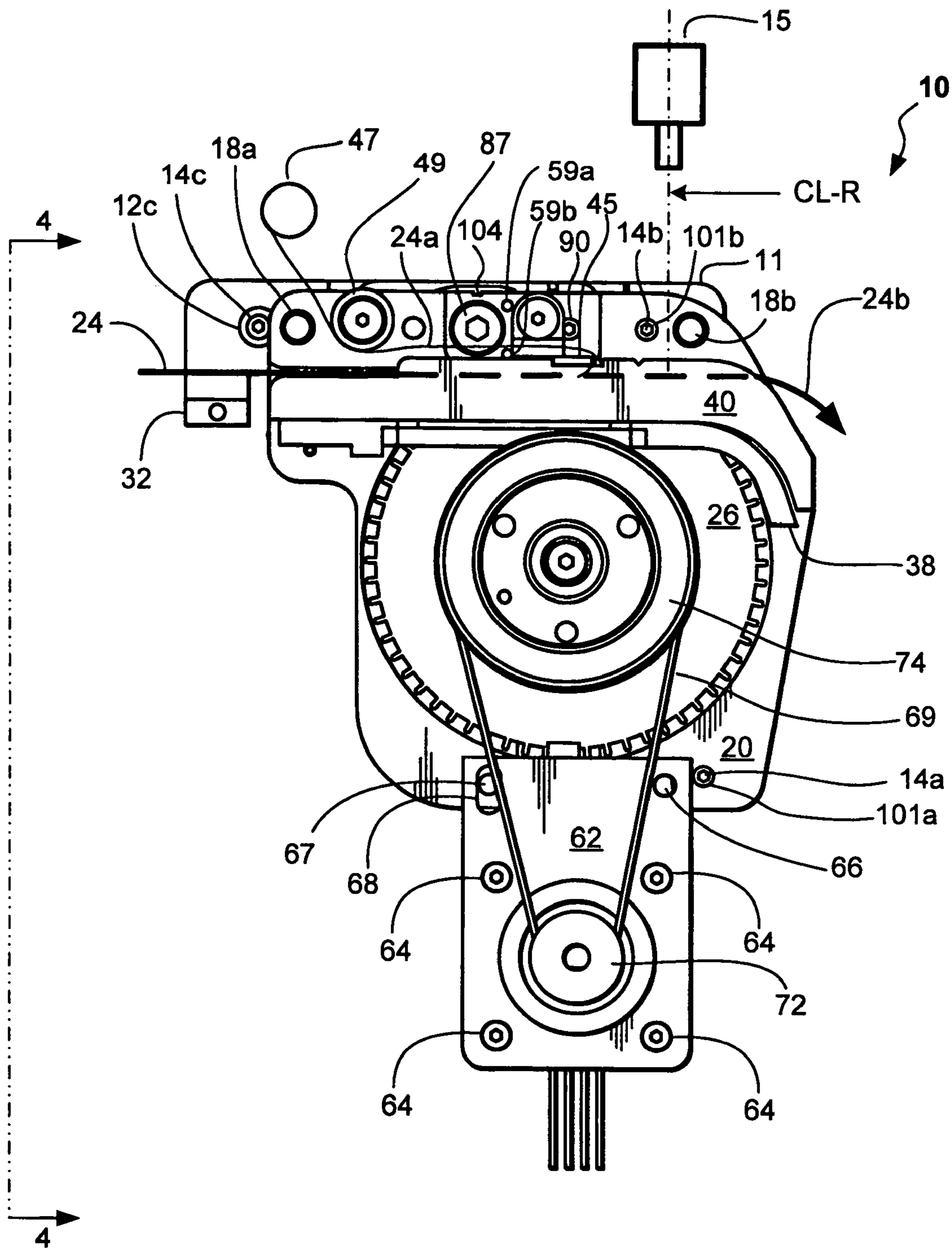


FIG. 3

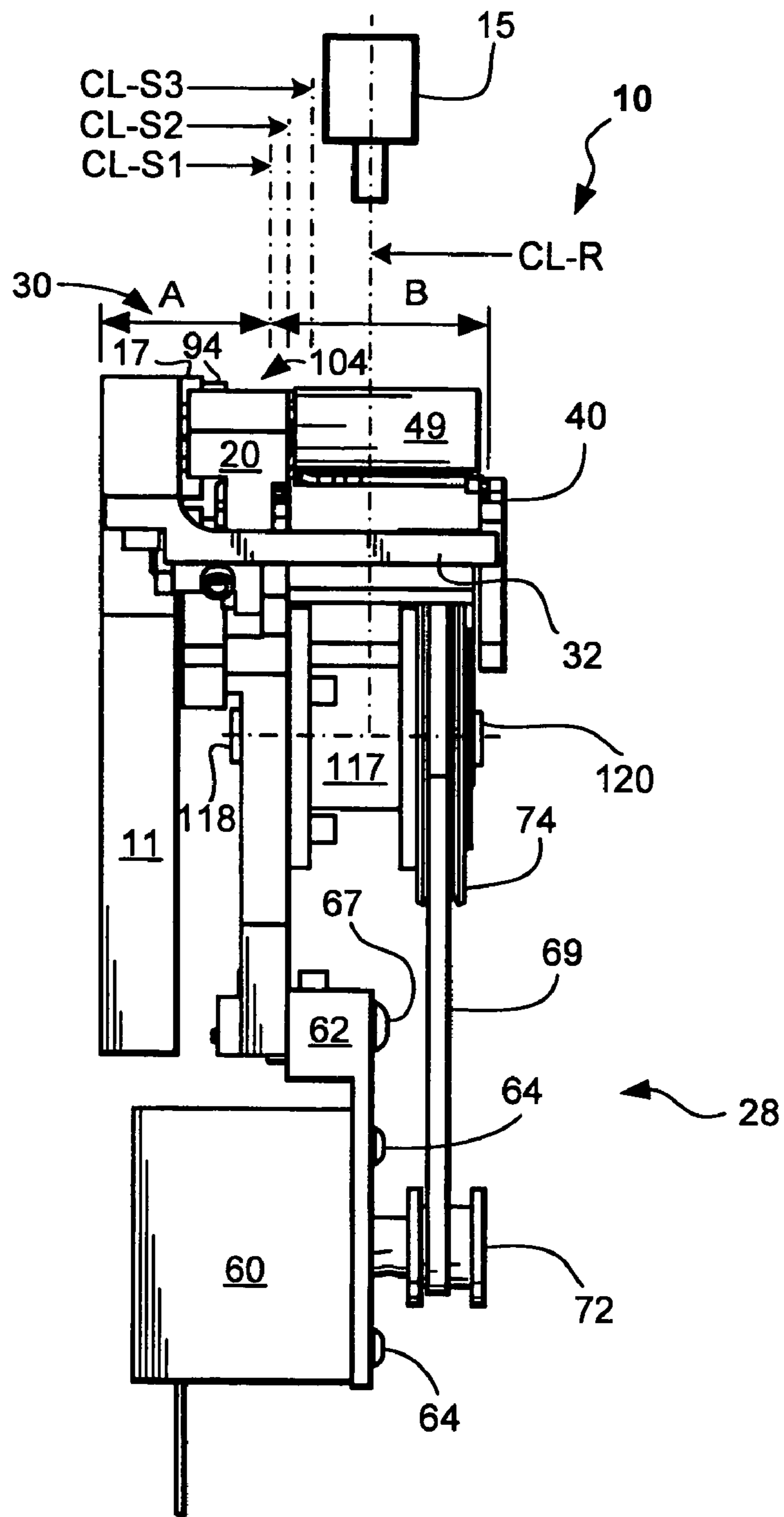


FIG. 4



**1****ADJUSTABLE MICRO DEVICE FEEDER**CROSS-REFERENCE TO RELATED  
APPLICATION(S)

This application claims the benefit of U.S. Provisional Application No. 60/440,479 filed Jan. 15, 2003, which is incorporated herein by reference thereto.

## TECHNICAL FIELD

The present invention relates generally to manufacturing system for electronic products, and more particularly to a micro device feeder system used in a manufacturing system.

## BACKGROUND ART

Certain operations of electronic circuit board assembly involved supplying micro devices by a micro device feeder to a robotic handling system. The micro devices include a broad range of electronic and mechanical devices, such as programmable devices. Programmable devices, which include but are not limited to devices such as Flash memories (Flash), electrically erasable programmable read only memories (E<sup>2</sup>PROM), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), and microcontrollers.

The micro device feeders are generally aligned and connected underneath the robotic handling system. The micro devices are typically supplied in tape on reel. The tape includes a plurality of pockets for containing the micro devices. Typically, there is only one pocket across the width of the tape. The tape has sprocket holes or perforations in one side so that it can be driven through the micro device feeder.

The micro device feeder has a frame upon which a motor and pulley arrangement is mounted to drive a sprocket, which engages the perforations to linearly drive the tape through the micro device feeder. The frame also carries a spring-loaded backup plate to support the tape and also accommodate any sudden variations in tension in the tape.

The robotic handling system removes the micro devices as the micro device feeder in the tape linearly presents them and places them on buffer areas of the micro device feeder or directly on printed circuit boards moving through an electronic assembly line or directly on printed circuit boards moving through an electronic assembly line or manufacturing system. In high-speed systems, the robotic handling systems are linearly moving pick-and-place mechanisms. In such a system, the centerline of the linearly moving pick-and-place mechanism must coincide with the centerline of the pockets in the linearly moving tape.

A major problem associated with the handling of micro devices carried on tapes is that different micro device feeders are needed for different size micro devices because they must be supplied in different size tapes. For example, three different micro device feeders are required for 16-, 24-, and 32-milimeter wide tape. The reason for requiring a different micro device feeder is that the centerline of the linearly moving pick-and-place mechanism does not coincide with the centerline of the pockets in the linearly moving tape for different tape widths because of the perforations in the side of the tape.

The perforations in the tape cause a different offset between the centerline of the pockets and the centerline of the tape for each different tape width. Since the frame is connected to the robotic handling system and also to the motor and pulley arrangement and the sprocket, the centerline of the linearly moving pick-and-place mechanism is fixed relative to the centerline of the sprocket. The centerline of the

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sprocket fixes the centerline of the perforations, which means that the offset causes the centerline of the pick-and-place mechanism to not coincide with the centerline of the pockets.

Since most companies have to handle different size micro devices supplied in tapes with different size tape widths, companies require a large number of different size micro device feeders, which is quite inconvenient and expensive.

Different approaches have been taken to try to solve this problem. One approach involves using a tape module, which forms a portion of the micro device feeder. The tape module is replaced for supplying micro devices contained in tapes with different widths. Therefore, instead of replacing the entire micro device feeder to accommodate for different size tape, only the corresponding tape module needs to be replaced. However, the tape module often constitutes almost half of the mechanism of a micro device feeder so it is still inconvenient and expensive to stock large number of tape modules to handle different size tapes.

Thus, a need remains for providing a micro device feeder, which is easily adjustable to accommodate micro devices supplied on tapes with different widths and is simple and inexpensive. In view of the increased demand for low-cost and efficient manufacturing of electronic products, including electronic circuit board assembly, it is increasingly critical that answers be found to this problem.

Solutions to this problem have been long sought but prior developments have not taught or suggested any solutions and, thus, solutions to this problem have long eluded those skilled in the art.

## DISCLOSURE OF THE INVENTION

The present invention provides a micro device feeder system, which is easily adjustable to accommodate micro devices supplied on tapes with different widths. The micro device feeder system is simple and inexpensive.

The present invention further provides a micro device feeder, which is adjustable to accommodate micro devices supplied on tapes with different widths. A mounting plate has a movable drive plate slidably mounted thereto. An input mechanism on the movable drive plate receives micro devices contained in a tape and advances the tape under motor drive. A feeder width adjustment mechanism is interposed between the mounting plate and the movable drive plate for positioning of the movable drive plate relative to the mounting plate for accommodating tapes with different widths.

Certain embodiments of the invention have other advantages in addition to or in place of those mentioned above. The advantages will become apparent to those skilled in the art from a reading of the following detailed description when taken with reference to the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric exploded view of a feeder system constructed according to the present invention;

FIG. 2 is another isometric exploded view of the feeder system of FIG. 1;

FIG. 3 is side view of the feeder system of FIG. 1; and

FIG. 4 is a side view of FIG. 3 taken along line 4-4.

BEST MODE FOR CARRYING OUT THE  
INVENTION

In the following description, numerous specific details are given to provide a thorough understanding of the invention. However, it will be apparent that the invention may be prac-



ticed without these specific details. In order to avoid obscuring the present invention, some well-known system configurations, and process steps are not disclosed in detail.

Likewise, the drawings showing embodiments of the apparatus are semi-diagrammatic and not to scale and, particularly, some of the dimensions are for the clarity of presentation and are shown greatly exaggerated in the FIGs. In addition, where multiple embodiments are disclosed and described having some features in common, for clarity and ease of illustration, description, and comprehension thereof, the same numbers are used in all the drawing FIGs. to relate to the same elements.

#### Structure:

Referring now to FIG. 1, therein is shown an isometric view of a feeder system 10 constructed according to the present invention. The term "vertical" as used herein is defined as a plane parallel to the height and width of a mounting plate 11, regardless of its orientation. The term "horizontal" refers to a direction perpendicular to the vertical as just defined. Terms, such as "on", "above", "below", "bottom", "top", "side", "higher", "lower", "over", and "under", are defined with respect to the horizontal plane. The terms "X-direction", "Y-direction", and "Z-direction" as used herein is represented by the respective orientation as shown in FIG. 1.

The mounting plate 11 includes three mounting holes 12a, 12b, and 12c. The mounting plate 11 is secured to a main frame 13 using screws 14a, 14b and 14c, which fit respectively in mounting holes 12a, 12b, and 12c. The feeder system 10 is coupled to the mounting plate 11 and is mounted on the main frame 13 using the mounting plate 11. The main frame 13 also carries a robotic handling system 15 (with a centerline CL-R).

The feeder system 10 includes a feeder mechanism 16, the mounting plate 11, an alignment block 17 mounted to the mounting plate 11, and a pair of guide pins 18a and 18b for guiding the feeder mechanism 16 and other mechanism mounted to it (which will later be described) when the feeder system 10 is repositioned for different tape widths in the Y-direction and locate it in the X- and Z-direction. The feeder mechanism 16 includes a movable drive plate 20 coupled to the mounting plate 11, an input mechanism 22 for receiving and guiding a tape 24 (represented by an arrow showing its linear path) containing micro devices (not shown), a tape driver or a sprocket 26 for engaging edge perforations in and advancing the tape 24, a drive mechanism 28 for driving the sprocket 26, and a feeder width adjustment mechanism 30.

The feeder width adjustment mechanism 30 permits adjustment of the feeder system 10 to accommodate tapes with different widths; i.e., different offsets between the centerline of the tape and the centerline of the different size pockets in the tape 24.

The engagement of the sprocket 26 in the perforations of the tape 24 assures positive linear movement of the tape 24 without Y-direction movement in and out from the main frame 13. The tape 24 includes a cover tape 24a and a carrier tape 24b. The carrier tape 24b has a plurality of pockets (not shown) for holding micro devices.

The movable drive plate 20 includes a guide mechanism 36 for accommodating the edges of the tape 24 proximate the perforations of the tape 24. In one embodiment, the guide mechanism 36 includes a groove.

The input mechanism 22 includes an external tape-guide mounting bracket 32 attached to the mounting plate 11 for supporting the tape 24, a guide carrier 38 mounted to the movable drive plate 20 for supporting the tape 24, and a tape

guide 40 mounted to the guide carrier 38 for accommodating the edge portion of the tape 24.

The input mechanism 22 also includes a cover tape removal mechanism 45 rotatably mounted to the movable drive plate 20 using a shaft 46 for removing the cover tape 24a, a cover tape mechanism 47 which handles disposal of the cover tape 24a by rolling it on to a spool or crushing it for later removal and disposal, and a tape-presence sensor assembly 48. The tape-presence sensor assembly 48 includes a tape-presence sensor roller 49, a sensor pin 50, and a pivot pin 51 for detecting the removal of cover tape 24a.

In an embodiment, the cover tape removal mechanism 45 includes a peel bar. As would be evident to those skilled in the art, the cover tape removal mechanism 45 may be a roller or other mechanisms suitable for removing the cover tape 24a.

The tape guide 40 includes a feature set. In this embodiment, the feature set includes openings 52a and 52b. The tape guide 40 also includes a notch 53 formed on its top surface.

The guide carrier 38 includes three pairs of projections 54a and 54b, 56a and 56b, and 58a and 58b. In one embodiment, the tape guide 40 includes magnets (not shown) built into it and the guide carrier 38 is made of a ferro-magnetic material. The tape guide 40 is removably attached to the guide carrier 38 using the magnetic force created between the magnets and the ferro-magnetic material. Depending on the width of the tape 24, the tape guide 40 is positioned on the guide carrier 38 by engaging openings 52a and 52b, with one of three pairs of projections 54a and 54b, 56a and 56b, and 58a and 58b.

In one embodiment, opening 52a is a slot opening, and opening 52b is a circular opening.

The movable drive plate 20 further includes an upper pin 59a and a lower pin 59b. The cover tape removal mechanism 45 is prevented from rotating around the shaft 46 beyond its operative location by the lower pin 59b and the notch 53 in the tape guide 40. When the tape guide 40 is to be switched between the pairs of projections 54a and 54b, 56a and 56b, and 58a and 58b, the cover tape removal mechanism 45 is rotated where it is supported in position by the upper pin 59a. After the tape guide 40 is switched to engage with another pairs of the pin pairs, the cover tape removal mechanism 45 is rotated where it is again supported in position by the lower pin 59b and the notch 53.

The drive mechanism 28 includes a motor 60 mounted on a motor bracket 62 using screws 64, which are best seen in FIG. 3. In FIG. 3, the motor bracket 62 is shown mounted to the movable drive plate 20 using screws 66 and 67. The motor bracket 62 is pivotable around the screw 66 and the screw 67 rides in a screw slot 68 to allow adjustment and holding of the motor bracket 62, and proper tensioning of a belt 69.

Referring back to FIG. 1, the motor 60 includes a drive shaft 70 and a motor pulley 72 mounted on the drive shaft 70. The motor pulley 72 drives a sprocket pulley 74 through the belt 69 from the motor 60. The adjustment of the motor bracket 62 allows proper tensioning of the belt 69. As would be evident to those skilled in the art, a tensioning mechanism may be provided to maintain the proper tension on the belt 69.

The alignment block 17 includes an alignment surface 80 formed at an angle of  $\theta^\circ$  with the lateral surface of the alignment block 17. The alignment surface 80 abuts a mounting plate surface 82 of the mounting plate 11. The mounting plate surface 82 is also formed at an angle of about  $\theta^\circ$  with the back surface of the mounting plate 11.

The alignment block 17 includes a top slot 84, a main slot 85, and a side slot 86. The alignment block 17 is secured to the mounting plate 11 using a screw 88, which is positioned within the side slot 86, and rests with the main slot 85 on a guide block 87, which is part of the mounting plate 11. When



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the screw **88** is loosened, the alignment block **17** can be slid along the side slot **86** and the guide block **87** in the X-direction on alignment surface **80**.

A screwdriver may be used to push against the top slot **84** to move the alignment block **17** in the X-direction to provide fine adjustment in the Y-direction position of the movable drive plate **20**. After the required alignment is completed, the alignment block **17** is secured to the mounting plate **11** using the screw **88**. In this embodiment, the screw **88** is tightened or loosened using a small Allen wrench extended through a hole **90** formed on the movable drive plate **20**. As would be evident to those skilled in the art, other type of screws or securing devices may be used. In an embodiment,  $\theta^\circ$  is about  $6^\circ$  to provide fine adjustment in the millimeter range between the mounting plate **11** and the movable drive plate **20**.

The feeder width adjustment mechanism **30** includes a 3-position spacer **94**. The 3-position spacer **94** includes three thickness **t1**, **t2** and **t3**, which are shown in FIG. 2. The thickness **t1**, **t2** and **t3** are used for spacing the movable drive plate **20** from the mounting plate **11**. Thus, the fine adjustment is accomplished using the alignment block **17** and the primary adjustment is accomplished using the 3-position spacer **94**.

Referring back to FIG. 1, the 3-position spacer **94** includes three recesses **96a**, **96b**, and **96c**. The 3-position spacer **94** is positioned between the alignment block **17** and the movable drive plate **20** to provide one of three positions for the movable drive plate **20**. The movable drive plate **20** is guided into position relative to the mounting plate **11** by engaging the guide pins **18a** and **18b** with respective holes **98a** and **98b**. The 3-position spacer **94** includes visual indicators **100a**, **100b**, and **100c**, which correspond to three different tape widths. Each of the visual indicators **100a**, **100b**, and **100c** indicates a corresponding position of the 3-position spacer **94** (and thus a corresponding spacing between the movable drive plate **20** and the mounting plate **11** as provided by the thickness **t1**, **t2**, and **t3**) when it is aligned with a recessed mark **104** formed on the top surface of the movable drive plate **20**. When the desired visual indicator **100a**, **100b**, or **100c** is aligned with the recessed mark **104**, the movable drive plate **20** is secured to the alignment block **17** and the mounting plate **11** using a screw **106**. In this embodiment, the visual indicators **100a**, **100b**, and **100c** are flat portions formed on the 3-position spacer **94**, for example, by machining of the 3-position spacer **94**. In another embodiment, the actual tape-widths in mm are engraved on the visual indicators **100a**, **100b**, and **100c**.

The movable drive plate **20** also includes access holes **101a** and **101b**. The screws **14a** and **14b** are tightened or loosened using an Allen wrench extended through access holes **101a** and **101b**, respectively. By removing screws **14a**, **14b**, and **14c**, the feeder system **10** can be easily separated from the main frame **13**.

Referring now to FIG. 2, therein is shown another isometric view of the feeder system **10** constructed according to the present invention. For simplicity of illustration, the mounting plate **11** and the main frame **13** are not shown.

The guide carrier **38** is shown mounted to the movable drive plate **20** using three screws **107**.

The tape guide **40** includes a guide mechanism **108** for accommodating the edges of the tape **24**. In an embodiment, the guide mechanism **108** includes a groove.

The 3-position spacer **94** is mounted to the movable drive plate **20** using a shoulder screw **110** which allows the 3-position spacer **94** to rotate about an axis of the shoulder screw **110**. To keep the 3-position spacer **94** in one of the three positions, the movable drive plate **20** includes a securing device **112**, such as a locating spring-loaded ball plunger. In

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an embodiment, the securing device **112** is on the back surface of the movable drive plate **20** such that it engages in one of the three recesses **96a**, **96b**, and **96c** (as shown in FIG. 1) and prevents the 3-position spacer **94** from rotating even when the screw **106** is not tightened.

The tape-presence sensor assembly **48** includes the tape-presence sensor roller **49** rotatably mounted to the sensor pin **50** (as best shown in FIG. 1) and secured by a screw **49a**, the pivot pin **51** supporting the sensor pin **50** and a sensor flag plate **114**, and a slot sensor **116** mounted to the movable drive plate **20**.

The cover tape **24a** is routed around the tape-presence sensor roller **49**. As the cover tape **24a** is pulled by the cover tape mechanism **47** (as shown in FIG. 3) and removed from the tape **24**, it causes the sensor pin **50** to rotate the sensor flag plate **114** up and clear a slot in the slot sensor **116**. If the tension on the cover tape **24a** is relieved, the sensor flag plate **114** rotates around the pivot pin **51** and blocks the slot sensor **116** under its own weight. This indicates that the cover tape **24a** is not removed from the tape **24** or is damaged and that the micro device at the pick-point is not exposed from underneath the cover tape **24a**. An error signal is sent to the host computer to indicate an error and alert operators that human intervention may be required to correct the error.

Referring now to FIG. 3, therein is shown a side view of the feeder system **10** of the present invention. For simplicity of illustration, the main frame **13** is not shown. The tape **24** is shown represented by an arrow showing its linear path through the feeder system **10**. The tape **24** is threaded by its edges along the guide mechanism **36** (as shown in FIG. 1) of the movable drive plate **20** and the guide mechanism **108** (as shown in FIG. 2) of the tape guide **40**. The cover tape removal mechanism **45** functions as a peeler for removing the cover tape **24a**. The cover tape **24a** is routed around the tape-presence sensor roller **49** and then connected to the cover tape mechanism **47**. The cover tape mechanism **47** applies tension to the cover tape **24a** to assure that it is peeled off of the carrier tape **24b**. The peeling off of the cover tape **24a** exposes the micro devices on the carrier tape **24b**. In one embodiment, the cover tape mechanism **47** includes a powered spool, which is activated to wind the cover tape **24a** during advancing of the tape **24**.

Referring now to FIG. 4, therein is shown a side view of the feeder system **10** along line 4-4 of FIG. 3. For simplicity of illustration, the main frame **13** is not shown.

The drive mechanism **28** also includes a sprocket shaft **117**, which is secured the movable drive plate **20** by a bolt **118** and to which the sprocket pulley **74** is secured using a bolt **120**.

The feeder width adjustment mechanism **30** includes the alignment block **17** and the 3-position spacer **94**. As an example, aligning the three visual indicators **100a**, **100b**, and **100c** (as shown in FIG. 1) with the recessed mark **104** on the movable drive plate **20** allows the movable drive plate **20** to be positioned so the sprocket **26** can be located with three different centerlines CL-S1, CL-S2, and CL-S3 for engaging the perforations of three different width tapes. Dimension A depends on the position of the 3-position spacer **94** and the alignment block **17**. Dimension B depends on the pairs of projections **54a** and **54b**, **56a** and **56b**, and **58a** and **58b** that are engaged with the tape guide **40**. The centerline CL-R of the robotic handling system **15** is the common centerline of the different width tapes **24** and the centerline CL-R is not effected by movement of the movable drive plate **20** and the tape guide **40**; i.e., the centerline of a pick and place mechanism will not be effected for different width tapes. Accordingly, the feeder system **10** in the example is capable of handling tapes with three different tape widths.



Operation:

First, an operator determines the size of the micro devices to be processed and the corresponding width of the tape used to contain the micro devices.

To align the feeder mechanism **16** with the robotic handling system **15**, the screw **106** is loosened. The movable drive plate **20** is moved away from the alignment block **17** by sliding along the pins **18a** and **18b**. According to the tape widths of the micro devices to be processed, the 3-position spacer **94** is rotated to one of the three positions by hand or by using a suitable tool. When the desired visual indicator (**100a**, **100b**, or **100c**) is aligned with the recessed mark **104**, the movable drive plate **20** is moved back to contact the alignment block **17**. The movable, drive plate **20** is now at the desired spacing from the mounting plate as determined by the 3-position spacer **94**. Since the movable drive plate **20** carries the sprocket **26**, adjustment of the 3-position spacer **94** provides a positive location of the sprocket **26** for the desired tape width. The screw **106** is then tightened. The securing device **112** engages with one of the three recesses **96a**, **96b**, and **96c** to prevent the 3-position spacer **94** from rotating freely.

Fine adjustment of the feeder mechanism **16** can be achieved by adjusting the position of the alignment block **17** in the X-direction. To adjust the position of the alignment block **17**, the screw **106** is loosened. Next, the screw **88** is loosened using a small Allen wrench extended through the hole **90**. A screwdriver may be used to push against the top slot **84** of the alignment block **17** to move it left or right to provide adjustment in its position. After the feeder mechanism **16** is precisely aligned with the robotic handling system **15**, the screw **88** is then tightened.

Next, the tape guide **40** is removed and repositioned on the guide carrier **38** so that openings **52a** and **52b** are engaged with the appropriate pairs of projections **54a** and **54b**, **56a** and **56b**, or **58a** and **58b**. In this embodiment, engagement of openings **52a** and **52b** with the projections **54a** and **54b** corresponds to the centerline CL-S1. Engagement of openings **52a** and **52b** with the projections **56a** and **56b** corresponds to the centerline CL-S2, and engagement of openings **52a** and **52b** with the projections **58a** and **58b** corresponds to the centerline CL-S3.

It will be understood that the exact order of the above operations is not critical. After the tape guide **40** is properly positioned, the feeder system **10** is ready for operation.

After the feeder system **10** is aligned with the pick-and-place system in the product assembly line, the operator feeds the tape **24** into the feeder mechanism **16**. The perforations formed on one side of the tape **24** engage with teeth of the sprocket **26**. The cover tape **24a** is threaded between the cover tape removal mechanism **45** and the tape-presence sensor roller **49**, and connected to the cover tape mechanism **47**. The motor **60** is turned on and the sprocket **26** rotates to drive the tape **24** while the cover tape mechanism **47** applies tension to the cover tape **24a** to assure that it is peeled off of the carrier tape **24b**. The micro devices on the tape **24** are presented in the proper position to the pick-and-place system.

Thus, the present invention provides a micro device feeder system, which is easily adjustable to accommodate micro devices supplied on tape with different widths and is simple and inexpensive.

From the above it will be understood that the present invention is applicable to what can be described as "micro devices". However, the present invention encompasses processing for all electronic, mechanical, hybrid, and other devices, which require testing, measurement of device characteristics, calibration, and other processing operations. For example, these types of micro devices would include but not be limited to

devices such as microprocessors, integrated circuits (ICs), application specific integrated circuits (ASICs), micro mechanical machines, micro-electro-mechanical (MEMs) devices, micro modules, and fluidic systems.

While the invention has been described in conjunction with a specific best mode, it is to be understood that many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications, and variations that fall within the spirit and scope of the included claims. All matters set hither-to-fore forth herein or shown in the accompanying drawings are to be interpreted in an illustrative and non-limiting sense.

The invention claimed is:

1. A micro device feeder system for providing micro devices in tapes to a production assembly line, comprising:
  - a mounting plate;
  - a movable drive plate coupled to the mounting plate;
  - an input mechanism mounted on the movable drive plate, the input mechanism capable of receiving the micro devices containing tapes;
  - a drive mechanism for driving the input mechanism; and
  - a feeder width adjustment mechanism including an angled alignment block interposed between the mounting plate and the movable drive plate for adjusting the micro device feeder system to accommodate tapes with different widths.
2. The micro device feeder system as claimed in claim 1 including:
  - a fine adjustment mechanism interposed between the mounting plate and the movable drive plate, the fine adjustment mechanism cooperating with the feeder width adjustment mechanism for making fine adjustments between the mounting plate and the movable drive plate.
3. The micro device feeder system as claimed in claim 1 wherein:
  - the feeder width adjustment mechanism comprises a multi-position spacer rotatably mounted to the movable drive plate, the multi-position spacer has a plurality of thicknesses, each one of the plurality of thicknesses determines one of a plurality of positions of the movable drive plate with respect to the mounting plate; and
  - the movable drive plate includes:
    - a securing device for securing the multi-position spacer to one or another or both of the mounting plate and the movable drive plate at the plurality of positions.
4. The micro device feeder system as claimed in claim 3 wherein:
  - the movable drive plate includes a mark; and
  - the multi-position spacer includes a plurality of visual indicators for indicating one of the plurality of positions of the multi-position spacer when one of the plurality of the visual indicators is aligned with the mark.
5. The micro device feeder system as claimed in claim 3 including:
  - a robotic handling system;
  - and wherein:
    - the multi-position spacer is adapted to align the input mechanism with the robotic handling system.
6. The micro device feeder system as claimed in claim 1 wherein:
  - the movable drive plate includes a first guide mechanism for accommodating the tapes along first edges of the tapes; and



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the input mechanism includes:

a guide carrier mounted to the movable drive plate for supporting the tapes; and

a tape guide removably mounted to the guide carrier, the tape guide including a second guide mechanism for accommodating the tapes along second edges of the tapes.

7. The micro device feeder system as claimed in claim 6 wherein:

the guide carrier includes a first plurality of feature sets; and

the tape guide includes a second feature for engaging with one of the first plurality of feature sets on the guide carrier to accommodate tapes with different widths.

8. The micro device feeder system as claimed in claim 6 wherein:

the guide carrier is formed of a ferro-magnetic material; and

the tape guide includes magnets for removably attaching the tape guide to the guide carrier using a magnet force created between the magnets and the ferromagnetic material.

9. The micro device feeder system as claimed in claim 8 wherein:

each of the first plurality of feature sets includes a plurality of projections; and

the second feature includes a set of openings formed on a bottom side of the tape guide for engaging with the plurality of projections.

10. The micro device feeder system as claimed in claim 1 wherein:

the input mechanism comprises a tape driver on the movable drive plate capable of engaging and advancing the tapes provided to the input mechanism, the tape driver engages the tapes along first edges of the tapes having a plurality of centerlines wherein the tapes have a common centerline; and

the tape driver is movable to accommodate the plurality of centerlines while maintaining the common centerline.

11. The micro device feeder system as claimed in claim 1 including:

a tape driver on the movable drive plate capable of engaging and advancing the tapes provided by the input mechanism;

and wherein:

the tape driver engages the tapes along first edges of the tapes having a plurality of centerlines wherein the tapes have a common centerline;

the tape driver is movable to accommodate the plurality of centerlines while maintaining the common centerline and assuring positive linear movement of the tapes; and

the drive mechanism is mounted on the movable drive plate to remain stationary relative to the tape driver.

12. The micro device feeder system as claimed in claim 1 wherein:

the input mechanism includes:

a cover tape removal mechanism secured to the movable drive plate for removing a cover tape off the tapes to expose the micro devices.

13. The micro device feeder system as claimed in claim 12 wherein:

the input mechanism includes:

a cover tape mechanism for disposing of the removed cover tape; and

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a tape-presence sensor assembly disposed between the cover tape removal mechanism and the cover tape mechanism for detecting the removal of the cover tape off the tapes.

14. The micro device feeder system as claimed in claim 13 wherein:

the tape-presence sensor assembly includes:

a slot sensor mounted to the movable drive plate;

a sensor flag plate rotatably mounted to the movable drive plate;

a tape-presence sensor roller rotatably mounted to the sensor flag plate wherein the sensor flag plate is clear of a slot in the slot sensor indicating the removal of the cover tape when the sensor flag plate enters the slot in the slot sensor indicating that the cover tape is not removed or is damaged.

15. A micro device feeder system for providing micro devices in tapes to a production assembly line, comprising:

a mounting plate;

an angled alignment block slidably mounted to the mounting plate;

a movable drive plate coupled to the mounting plate and slidable with respect thereto;

an input mechanism mounted on the movable drive plate and movable therewith, the input mechanism capable of receiving the micro devices containing tapes, the input mechanism comprising a sprocket on the movable drive plate, the sprocket capable of engaging perforations provided in first edges of the tapes and advancing the tapes provided to the input mechanism;

a drive mechanism for driving the sprocket; and

a feeder width adjustment mechanism including the angled alignment block for adjusting the micro device feeder system to accommodate tapes with different widths by moving the sprocket relative to a common centerline of the tapes, the feeder width adjustment mechanism including:

a multi-position spacer mounted on one or the other or both of the mounting plate and the movable drive plate and disposed between the movable drive plate and the angled alignment block, the multi-position spacer cooperating with the angled alignment block for determining a plurality of positions of the movable drive plate with respect to the mounting plate.

16. The micro device feeder system as claimed in claim 15 wherein:

the mounting plate includes a mounting surface formed at an angle between the mounting plate and the movable drive plate; and

the angled alignment block includes an alignment surface formed at an angle to the mounting plate and the movable drive plate to allow the angled alignment block to be slidably engaged with the mounting surface for positioning the movable drive plate with respect to the mounting plate.

17. The micro device feeder system as claimed in claim 15 wherein:

the movable drive plate includes:

a recess mark;

a securing device; and

the multi-position spacer is rotatably mounted to the movable drive plate, and includes:

a plurality of thicknesses;

a plurality of recesses, each one of the plurality of thicknesses determines one of the plurality of positions of the movable drive plate with respect to the mounting plate, wherein the securing device secures the multi-position



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spacer to the movable drive plate at the plurality of positions by engaging a respective one of the plurality of recesses; and

a plurality of visual indicators for indicating one of the plurality of positions of the multi-position spacer when one of the plurality of the visual indicators is aligned with the recess mark.

18. The micro device feeder system as claimed in claim 15 including:

a robotic handling system;

and wherein:

the multi-position spacer is adapted to align the input mechanism with the robotic handling system.

19. The micro device feeder system as claimed in claim 15 wherein:

the movable drive plate includes a first guide mechanism for accommodating the tapes along first edges of the tapes; and

the input mechanism includes:

a guide carrier mounted to the movable drive plate for supporting the tapes; and

a tape guide removably mounted to the guide carrier, the tape guide including a second guide mechanism for accommodating the tapes along second edges of the tapes.

20. The micro device feeder system as claimed in claim 19 wherein:

the guide carrier is formed of a ferro-magnetic material and includes:

a first plurality of feature sets, each of the first plurality of feature sets including a plurality of projections; and

the tape guide includes:

magnets for removably attaching the tape guide to the guide carrier; and

a second feature, the second feature including a set of openings formed on a bottom side of the tape guide for engaging with each one of the plurality of feature sets to accommodate tapes with different widths.

21. The micro device feeder system as claimed in claim 15 wherein:

the sprocket engages the tapes along first edges of the tapes having a plurality of centerlines wherein the tapes have a common centerline; and

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the sprocket is movable to accommodate the plurality of centerlines while maintaining the common centerline.

22. The micro device feeder system as claimed in claim 15 wherein:

the sprocket engages the perforations of the tapes having a plurality of centerlines wherein the tapes have the common centerline;

the sprocket is movable to accommodate the plurality of centerlines while maintaining the common centerline and assuring positive linear movement of the tapes;

the drive mechanism is mounted on the movable drive plate to remain stationary relative to the sprocket and includes:

a motor secured to the movable drive plate, a motor pulley on the motor,

a sprocket shaft on the movable drive plate, a sprocket pulley on the sprocket shaft, and

a belt connected to drive the sprocket pulley from the motor; and

the sprocket is secured to the sprocket pulley.

23. The micro device feeder system as claimed in claim 15 wherein:

the input mechanism includes:

a cover tape removal mechanism secured to the movable drive plate for removing a cover tape off the tapes to expose the micro devices;

a cover tape mechanism for disposing of the removed cover tape; and

a tape-presence sensor assembly disposed between the cover tape removal mechanism and the cover tape mechanism for detecting the removal of the cover tape off the tapes, the tape-presence sensor assembly including:

a slot sensor mounted to the movable drive plate;

a sensor flag plate rotatably mounted to the movable drive plate;

a tape-presence sensor roller rotatably mounted to the sensor flag plate wherein the sensor flag plate is clear of a slot in the slot sensor indicating the removal of the cover tape when the sensor flag plate enters the slot in the slot sensor indicating that the cover tape is not removed or is damaged.

\* \* \* \* \*



UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 7,472,737 B1  
APPLICATION NO. : 10/759759  
DATED : January 6, 2009  
INVENTOR(S) : Rossen Atanassov Rachkov

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In column 7, line 14, after “movable” delete “,”.

Signed and Sealed this

Twenty-eighth Day of April, 2009



JOHN DOLL  
*Acting Director of the United States Patent and Trademark Office*